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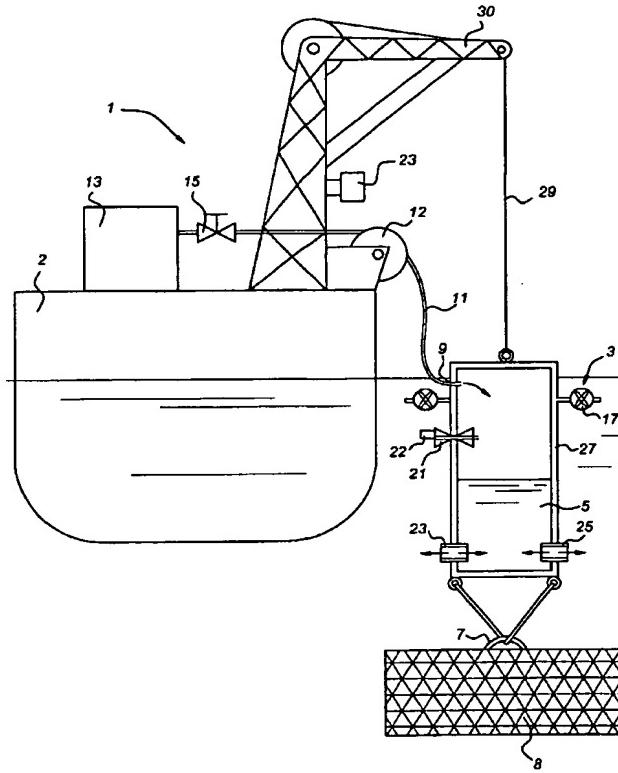
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[Continued on next page]

(54) Title: FLOATING LOWERING AND LIFTING DEVICE



(57) Abstract: The invention relates to a floating lowering and lifting device (1) comprising a floating structure (2) and a lifting unit (3) lowerable from the floating structure (2) towards the sea bed, the lifting unit (3) having a chamber (5) with at least one gas-inlet opening (9) in its wall (27) and an equalisation opening (23, 25) in its wall (27), a gas supply means (13) being connected to the gas inlet opening (9), the device comprising a control means (15) connected to the gas supply means (13) for controlling a gas supply rate to the chamber (5), wherein the chamber (5) comprises a releasable coupling member (7) for releasably attaching to a load (8).

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Floating lowering and lifting device

The invention relates to a floating lowering and lifting device comprising a floating structure and a lifting unit lowerable from the floating structure towards the sea bed.

It is known to lower large weight loads (templates for example) onto the seabed with cables from a floating barge. A problem with prior art systems which use a tensioned connection between the weight and the floating vessel, like a cable, to take the weight, is that due to the movements of the floating vessel snap tensions will be introduced in the cable.

As very long cables and very large weights are used, these snap tensions can break the cable (this problem is solved by the construction according to US Patent No. 5190107, a heave compensating support system for positioning a sub sea work package). In very deep waters and with very large weights, the diameter and the weight of the cables are becoming to big to handle: for example the weight of a 6 inch cable of 1000 m is about 100 tons and the diameter of the cable will be to big to handle.

It is possible to use devices to lower packages onto the seabed with the help of pressurized closed buoyancy cans. The cans must be so constructed to withstand the water pressure at seabed level; every 10 m water depth will add 1 bar. Such a system is shown in the above US Patent No. 5190107.

Very deep waters have relative high pressures at seabed level. This, combined with the relatively large weight to be transported makes the use of closed buoyant cans or modules very expensive due to the size of such a buoyancy module and the construction needed to avoid collapsing of the buoyancy module.

It is therefore an object of the present invention to provide a lowering and lifting device for lifting or lowering relatively heavy weights in deep water.

It is a further object of the present invention to provide a lowering and lifting device which can be raised and lowered in a controlled manner using a simple and reliable control system.

Thereunto, the lowering and lifting device according to present invention comprises a chamber with at least one gas inlet opening in its wall and an equalisation opening in its wall, a gas supply means being connected to the gas inlet opening, the device comprising a control means connected to the gas supply means for controlling a

gas supply rate to the chamber, wherein the chamber comprises a releasable coupling member for releasably attaching to a load.

The device according to the present invention can be used for lowering to the seabed of heavy loads (500 tons or more) in relative deep water (for example 1000m).

- 5 The lifting unit can be connected to and disconnected from the load and includes a large, "soft volume" structure which has an opening to the environment in the lower part and which can be filled with a gas above its opening to add buoyancy. Due to the fact that the chamber if the lifting unit is not a closed pressure module, the construction can be relative simple and can be constructed at low costs as there will be no pressure differences between the inside and the outside of the module. The gas (air) inside the open chamber will compensate the weight of the chamber and the weight of the load to be transported to or from the seabed, at any position during the lowering and raising. Adding gas will ensure a controlled lowering /deployment of the combination of the device and the connected package, for example creating an uplift of 490-500 tons at a
- 10 load of 500 tons. During the way down, gas (such as for instance air or Nitrogen) needs to be added into the chamber as the gas trapped in it will be reduced in volume due to the increase of the external water pressure. The combination of lifting device and load sinks due to the resultant small negative buoyancy of the combination, which can be controlled, from the floating barge by a vent system on the module. After depositing
- 15 the load on the seabed, gas is removed from the chamber via a gas release mechanism to maintain neutral buoyancy on a small positive buoyancy after disconnecting of the load such that the lifting unit can be retrieved at the water surface.

- 20
- 25 The control means connected to the gas supply means can comprise for instance an electrically or mechanically controlled valve in a gas supply duct to the chamber, or a remote control valve on the chamber which is actuated by means of a sonar system or radio transmitter or any equivalent means such as fibre optics or any other signal carriers.

- 30 During operation, the gas inlet opening is during use situated higher along a longitudinal height of the lifting unit than the equalisation opening. Gas introduced into the chamber will accumulate at the top whereas pressure equalisation with the surroundings takes place through the lower equalisation opening.

The gas supply means may, according to one embodiment, be placed on the floating structure, a fluid supply duct connecting the gas supply means to the chamber.

The fluid supply duct may be a flexible duct can be connected to a container with compressed gas or a compressor supplying gas to the chamber with an over pressure. The control means may comprise a valve connected to the supply duct, which can be actuated from on board the floating structure or may be formed of a power control 5 operatively associated with the compressor to regulate the compressor output, or combinations thereof.

In another alternative embodiment, the gas supply means comprise a container which is connected to the chamber via a controllable valve, the container comprising compressed gas and being lowerable with the chamber, the control means being .0 connected to the valve for controlling the gas supply to the chamber. The control means may comprise a cable connected to a supply setting unit on board of the vessel on one side and connected to the valve which is lowered with the chamber on the other side. The cable may comprise electrical, optical or other means of signal transmission. Alternatively, an acoustic receiver may be comprised on the valve being lowered with 15 the chamber whereas a transmitter is placed on board of the vessel. Again, a radio transmitter may be comprised on board of the vessel whereas the receiver is connected to the valve of the container connected to the chamber for opening or closing said valve.

Even though the chamber has a controlled buoyancy during raising and/or 20 lowering of the load, the lifting unit may be connected to the vessel via a guide cable for assisting in station keeping of the lifting unit and for preventing drift or positional change with respect to the vessel and for retrieval of the lifting unit on board of the vessel.

For positional adjustment, the chamber may be provided with one or more 25 thrusters powered via the control line. For heave compensation an tensional equalisation in the guide cable and/or control line, the guide line or control line may be connected to an arm on the floating structure, the arm comprising a sheeve and a counter weight attached to the sheeve via an arm, the sheeve being suspended from said arm. This way a heave compensating adjustment is achieved. For controlled raising or 30 lowering a gas release mechanism is connected to a control means adapted to be opened upon detaching the releasable coupling member from the load. In this way, the buoyancy of the unit can be reduced prior to detaching of the load and the lifting unit

will not be accelerated upwards by its reduced mass, but can be raised to the surface in a controlled manner.

Some embodiments of a floating lowering and lifting device according to the present invention, will, by way of example, be explained in detail with reference to the 5 accompanying drawings. In the drawings:

Fig. 1 shows a schematic view of the first embodiment which the chamber of the lifting device is supplied with gas from floating structure;

Fig. 2 is an embodiment in which the chamber of the lifting device is provided with a compressed gas source connected to the chamber;

10 Fig. 3 is an embodiment which a closed volume filled with foam or gas is comprised in the device; and

Fig. 4 is an embodiment comprising a heave and roll compensating mechanism.

Fig 1 shows a floating lowering and lifting device 1 comprising a vessel or barge 2 and a lifting unit 3. Lifting unit 3 comprises a chamber 5 provided with a releasable 15 coupling member 7 carrying a load 8 that is to be raised from or lowered to the seabed. The chamber 5 comprises gas inlet opening 9 which is connected to a gas supply hose 11. The air hose 11 may be wound on an air hose reel 12 and may be attached to gas supply means 13 which may formed of a compressor or which may be a storage tanker comprising gas or compressed gas. A control valve 15 may be included in the air hose 20 11 for increasing or decreasing the gas supply rate from the tank of compressed air 13. The chamber 5 comprises furthermore a thruster 17 for positioning of the chamber and a controllable gas release valve 21, which may comprise a sonar detector 22 for communicating with sonar transmitter 23 for opening or closing of the valve 21. Sonar transmitter 23 may be operated from the vessel 2. Furthermore, the chamber 5 25 comprises equalisation openings 23, 25 in the lower wall 27 of the chamber 5 for equalising the pressure inside the chamber 5 with the ambient pressure. By controlling the valve 15, the gas supply rate to the chamber 5 is adjusted such as to lower the load 8 in a controlled manner at the same time the air hose is wound from the reel 12 for positional purposes and for retrieval of the chamber 5 onto the vessel, the chamber 5 is 30 connected to a guide cable 29 that is connected to a crane 30 on the vessel.

Fig. 2 shows an embodiment in which tank 32 comprising compressed nitrogen is attached to the chamber 5. Compressed nitrogen can be entered into chamber 5 via a controllable valve 31 which is connected to electric signal control cable 32, operated

from onboard of the vessel 2. A release valve 21 which can be electrically controlled is also connected via cable 32 to a control unit 33 on board of the vessel 2. Instead of via a cable 32, the valves 21, 31 may be operated via a radiographic control or via sonar or even via remote operated vehicle (ROV) which lowered together with the chamber 5 and which is operated from a control unit on board of the vessel 2.

In the embodiment of Fig. 3 the chamber 5 comprises a closed volume 34 with permanent buoyancy comprising air or foam. The amount of air or foam in the enclosed space 34 may be just sufficient for providing a neutral buoyancy of the chamber 5 when the load has been deposited on the seabed.

0 Once the load has been deposited on the seabed, the gas in the chamber 5 that was compensating for the weight of the load 8 must be ventilated when the seabed will take the weight of the load upon lowering of the load 8 and pressural transmission of its weight onto the seabed, the release valve 21 (see Fig. 2) is operated to gradually release gas from the chamber 5 to prevent the chamber 5 from rocketing up to sea level. During
5 the upwards trajectory gas is released via gas release valve 21 in a controlled manner for a controlled lift. Upon lowering of the chamber 5, gas is introduced into the chamber 5 in a controlled manner via valve 15 or 31 to compensate for the volume reduction of the gas by increased compression with increasing water depth. For this purpose the valve 15 and/or the compressor 16 on board of the vessel 2 may be
10 operated in a way which is controlled by the water depth of the chamber 5.

The air hose 11 can be a relatively small diameter flexible tube. The guide cable 29 of the floating barge 2 can be of relatively small dimensions as it does not need to take the weight of the whole chamber 5 and the load 8, as the combined chamber 5 and load 8 are maintained generally at neutral buoyancy. The function of the guide cable 21
25 is to guide or to keep the track of the device 3 and the load 8 and to take up a limited amount of weight (for example the cable is able to take 10 tons at a combined weight of load 8 and chamber 5 of for instance 500 tons). Together with the air hose 11 an umbilical may be connected to the chamber 5 for operating thruster 17 and/or for controlling the air release valve 21 in Fig. 1.

30 In the compressor 16 in Fig. 3, a power control 14 is present for relating the air supply to chamber 5 in dependence of the water depth.

Finally in Fig. 4, it is shown that the guide cable 29 is connected to a sheeve 42 at the end of an arm 43. At the second end of the arm 43 a counter weight 44 is provided.

The arm 43 is near its midpoint connected to a cable 45 attached to crane 30. The guide cable 29 is wound on a winch 41. By the arm 43, a heave/roll compensating device is provided which prevents large tensioned loading in the guide cable 29 upon heave-induced motions and roll of the vessel 2.

Claims

1. Floating lowering and lifting device comprising a floating structure and a lifting unit lowerable from the floating structure towards the sea bed, the lifting unit having a chamber with at least one gas-inlet opening in its wall and an equalisation opening in its wall, a gas supply means being connected to the gas inlet opening, the device comprising a control means connected to the gas supply means for controlling a gas supply rate to the chamber, wherein the chamber comprises a releasable coupling member for releasably attaching to a load.
- .0
2. Floating lowering and lifting device according to claim 1, the gas inlet opening during use being situated higher up along a longitudinal height of the lifting unit than the equalisation opening.
- 15 3. Floating lowering and lifting device according to claim 1 or 2, wherein the gas supply means are placed on the floating structure, a fluid supply duct connecting the gas supply means to the chamber.
- 20 4. Floating lowering and lifting device according to claim 3, wherein the gas supply means comprises a container with a compressed gas, the control means comprising a valve connected to the fluid supply duct, or a compressor, the control means comprising a power control operatively associated with the compressor.
- 25 5. Floating lifting device according to claim 1 or 2, wherein the gas supply means comprise a container connected to the chamber via a controllable valve, the container comprising a compressed gas and being lowerable with the chamber, the control means being connected to the valve for controlling the gas supply to the chamber.
- 30 6. Floating lifting device according to any of the preceding claims, wherein the chamber is suspended from the floating structure via a guide cable.
7. Floating lifting device according to any of the preceding claims, the chamber comprising at least one thruster powered via the control line.

3. Floating lifting device according to any of the preceding claims, wherein the chamber comprises a closed compartment.

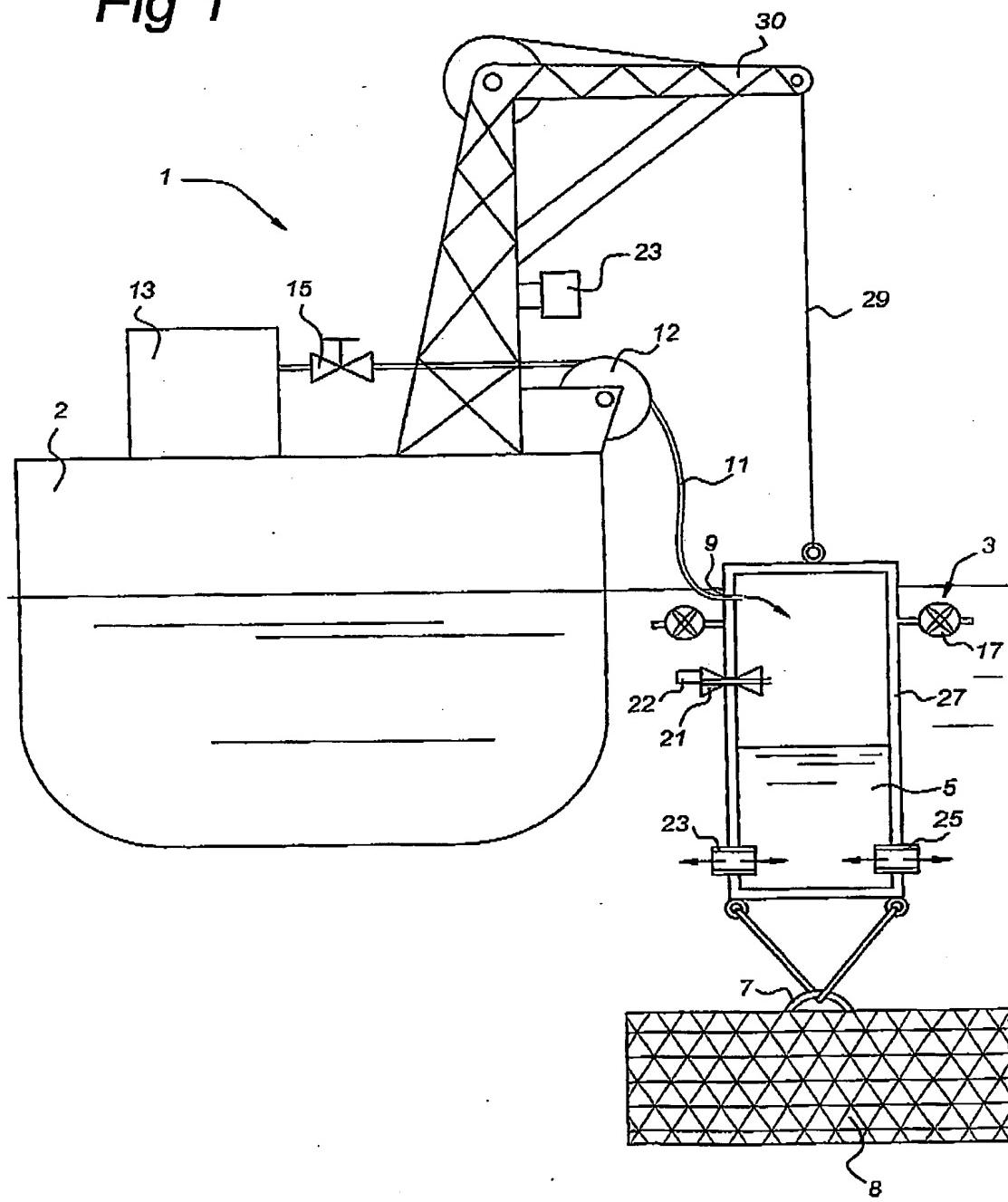
5 9. Floating lifting device according to any of the preceding claims, wherein the guide cable or control line is connected to an arm on the floating structure, the arm comprising a sheave, and a counterweight attached to the sheave via an arm, the sheave being suspended from the arm.

.0 10. Floating lowering and lifting device according to any of the preceding claims, having a gas release mechanism connected to a control means which is adapted to open the gas release mechanism after placing the load on the sea bed, prior to detaching the releasable coupling member.

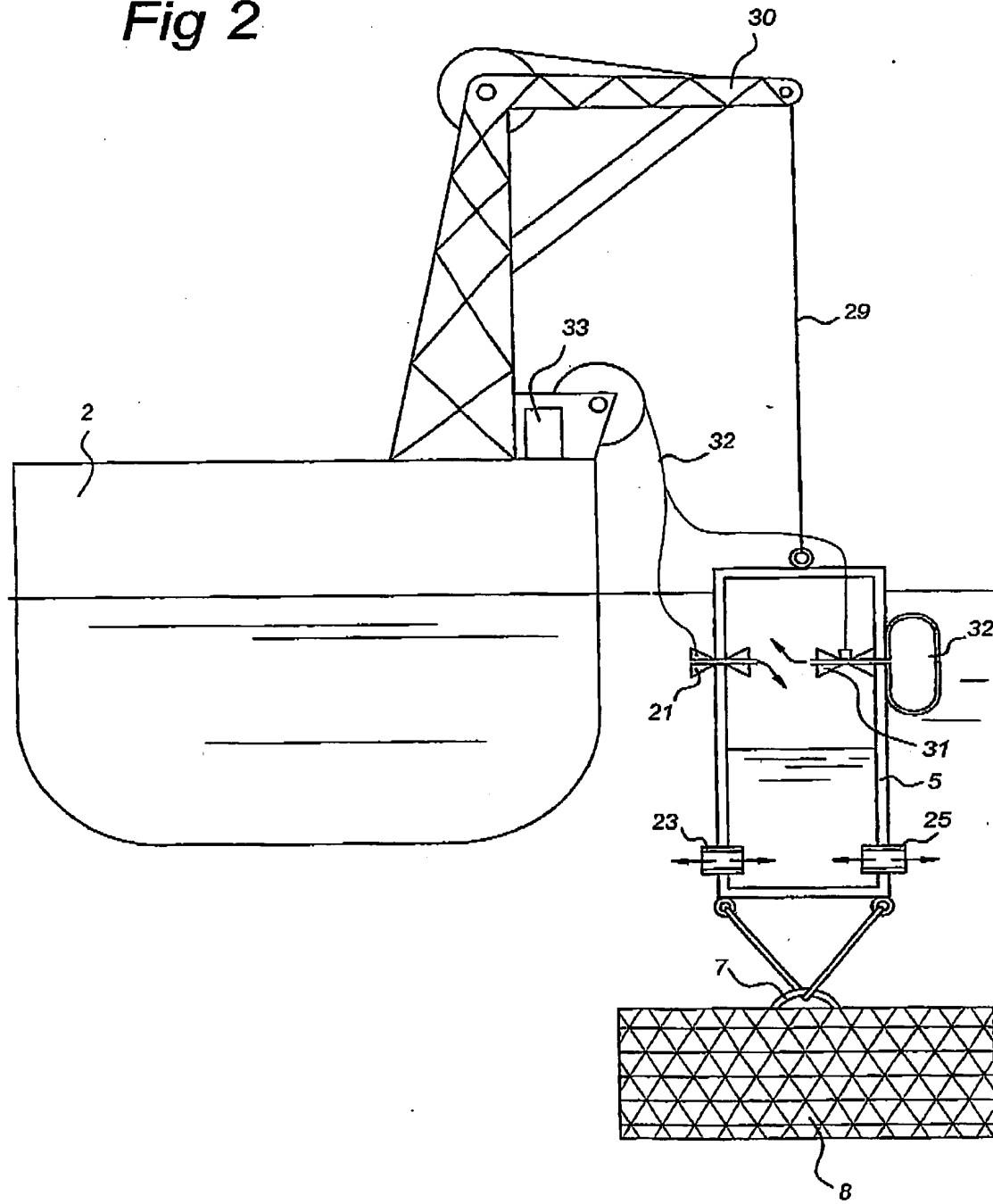
11. Method of raising and lowering an object from the seabed comprising the steps
15 of:
- attaching a load to the lifting unit according to any of the preceding claims;
- adding or releasing a gas into or from the chamber in dependence of the water depth while maintaining an open connection of the chamber with the sea via the equalisation opening.

20 12. Method according to claim 11, wherein upon depositing the load onto the seabed gas is released from the chamber to maintain a substantially predetermined buoyancy when the weight of the load is transferred from the lifting unit to the seabed.

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Fig 1

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Fig 2

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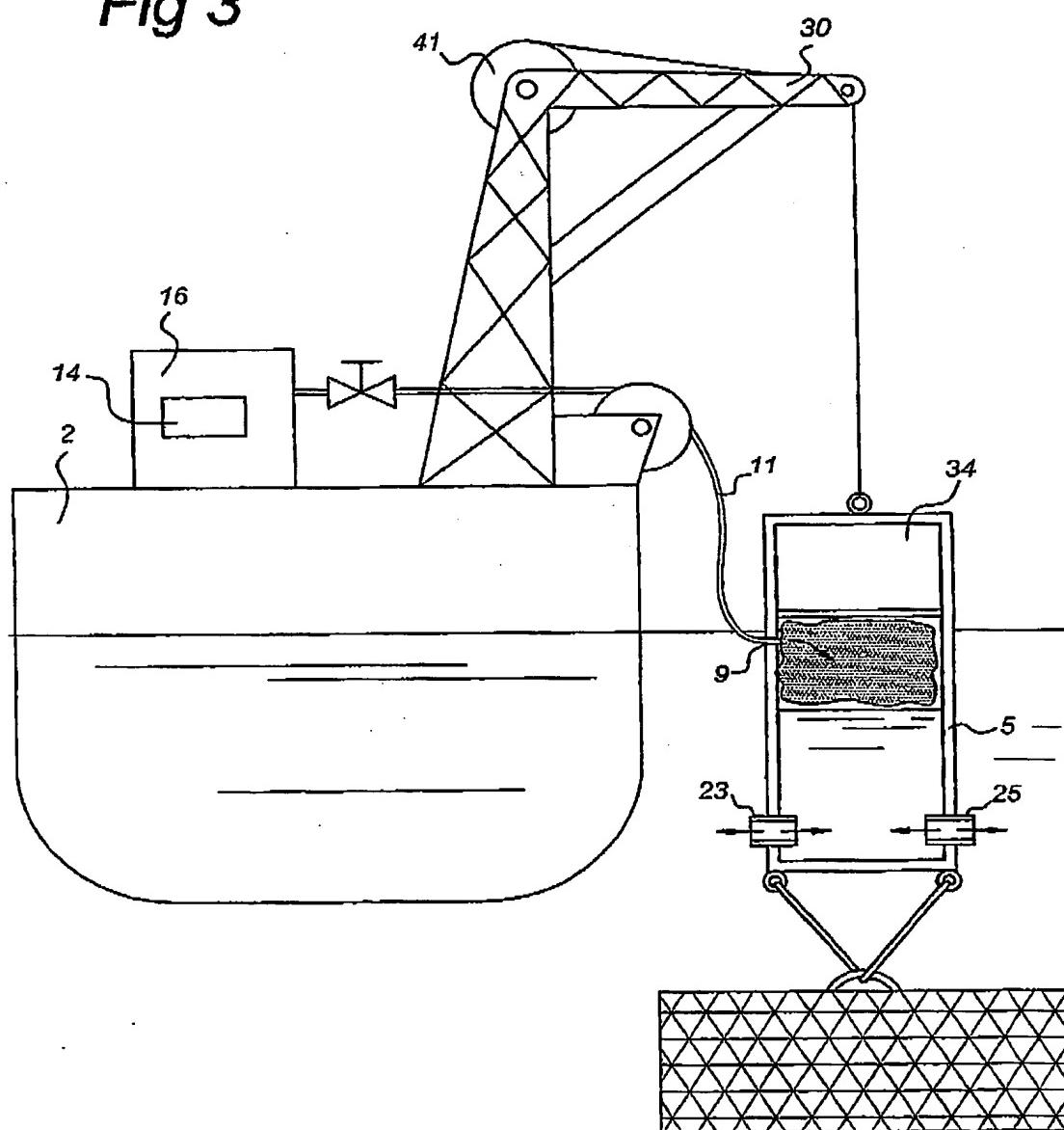
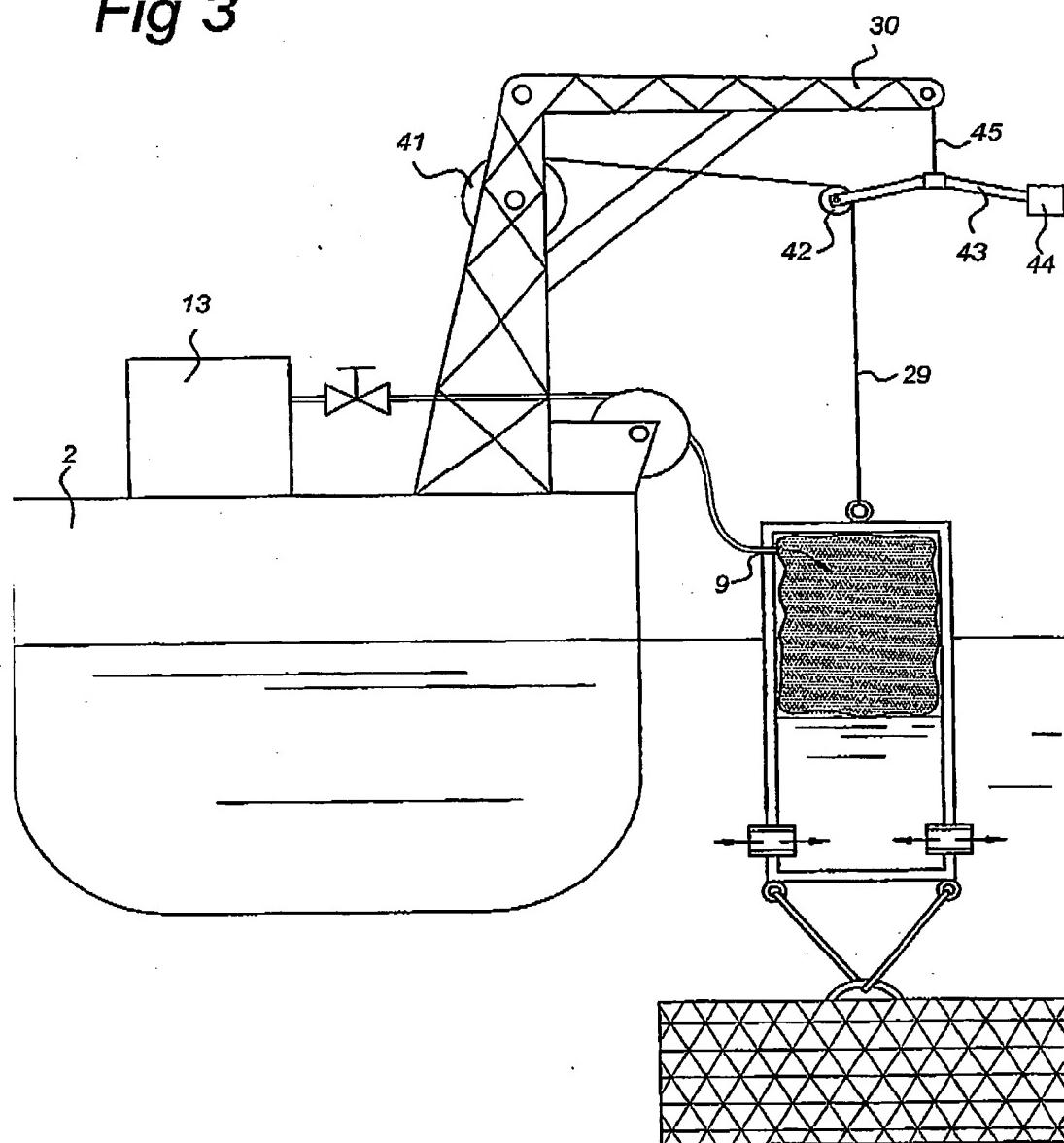
Fig 3

Fig 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/08066

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B63B27/10 B63B35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 097 786 A (SHEFFIELD WOODROW W) 24 March 1992 (1992-03-24) abstract; figures 3-8 column 4, line 53 -column 7, line 48	1-4, 7, 8, 10-12 5, 6, 9
X	US 4 683 832 A (DYSARZ EDWARD D) 4 August 1987 (1987-08-04) abstract; figures column 3, line 62 -column 5, line 64	1, 3, 4, 6-8, 10-12
Y	US 6 082 947 A (ADAMSON JAMES E) 4 July 2000 (2000-07-04) abstract; figures column 1, line 5-45	6, 9
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/08066

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 633 369 A (LAWRENCE JOSEPH BENTON) 11 January 1972 (1972-01-11) abstract; figures 1,3,6 column 4, line 40-43	5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 03/08066

Patent document cited in search report	Publication date		Patent family member(s)	Publication date
US 5097786	A 24-03-1992	AU GB NO WO	4415489 A 2252996 A ,B 911124 A 9003470 A2	18-04-1990 26-08-1992 22-05-1991 05-04-1990
US 4683832	A 04-08-1987	NONE		
US 6082947	A 04-07-2000	NONE		
US 3633369	A 11-01-1972	NONE		

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